Gnu/Linux File Permissions

Insight GNU/Linux Group

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Goal

- Understand the following:
- The Unix security model
- How a program is allowed to run
- Where user and group information is stored
- Details of file permissions

Users and Groups

- Unix understands Users and Groups
- A user can belong to several groups
- A file can belong to only one user and one group at a time
- A particular user, the superuser “root” has extra privileges (uid = “0” in /etc/ passwd)
- Only root can change the ownership of a file for all

Users and Groups cont.

User information in /etc/passwd

Password info is in /etc/shadow

Group information is in /etc/group

/etc/passwd and /etc/group divide data fields using a colon “:”

Example /etc/passwd:

```
ilg:x:500:500:ilg:/home/ilg:/bin/bash
```

Example /etc/group:

```
ilg:x:500:
```

When a Program Runs...

A program may be run by a user, when the system starts or by another process.

Before the program can execute the kernel inspects several things:

- Is the file containing the program accessible to the user or group of the process that wants to run it?
- Does the file containing the program permit execution by that user or group (or anybody)?
- In most cases, while executing, a program inherits the privileges of the user/process who started it.

Program Details

When we type:

```
ls -l /usr/bin/top
```

We'll see:

```
-r-xr-xr-x 1 root wheel 46112 Apr 28 10:52 /usr/bin/top
```

What does all this mean?

```
-r-xr-xr-x  1  root    wheel    46112   Apr 28 10:52 /usr/bin/top
---------- --- ------- ------- -------- ------------ -------------
    |       |      |       |        |          |               |
    |       |      |       |        |          |           File Name
    |       |      |       |        |          |
    |       |      |       |        |          +---  Modification Time/Date
    |       |      |       |        |
    |       |      |       |        +-------------   Size (in bytes
    |       |      |       |
    |       |      |       +-----------------------  Group
    |       |      |
    |       |      +-------------------------------  Owner
    |       |
    |       +------------------------------------- --  “link count”
    |
    +------------------------------------------  File Permissions
```

Group

The name of the group that has permissions in addition to the file's owner.

Owner

The name of the user who owns the file.

File Permissions

A representation of the file's access permissions. The first character is the type of file. A "-" indicates a regular (ordinary) file. A "d" would indicate a directory. The second set of three characters represent the read, write, and execution rights of the file's owner. The next three represent the rights of the file's group, and the final three represent the rights granted to everybody else.

(Example modified from http://www.linuxcommand.org/lts0030.php)

Difference in access permissions for files and folders

- Access permissions for files and folders mean different things from the user standpoint.

Access type	File	Folder
Read	If the file contents can be read	If the directory listing can be obtained
Write	If user or process can write to the file (change its contents)	If user or process can change directory contents somehow: create new or delete existing files in the directory or rename files.
Execute	If the file can be executed	If user or process can access the directory, that is, go to it (make it to be the current working directory)

Access Rights

- Files are owned by a user and a group (ownership)
- Files have permissions for the user, the group, and other
- “other” permission is often referred to as “world”
- The permissions are Read, Write and Execute (r, w, x)
- The user who owns a file is always allowed to change its permissions

Some Special Cases

- When looking at the output from “ls -l” in the first column you might see:

d = directory

- = regular file (txt,executable,data) *use 'file' or 'stat' command to know which kind of file.*

l = symbolic link

s = Unix domain socket

p = named pipe

Inter process comm(IPC)

c = character device file (usb,tty,k.b,mouse)

b = block device file (hdd, cdrom,ram)

Device files

Some Special Cases cont.

In the Owner, Group and other columns you might see:

s = setuid	[when in Owner column]
s = setgid	[when in Group column]
t = sticky bit	[when at end]

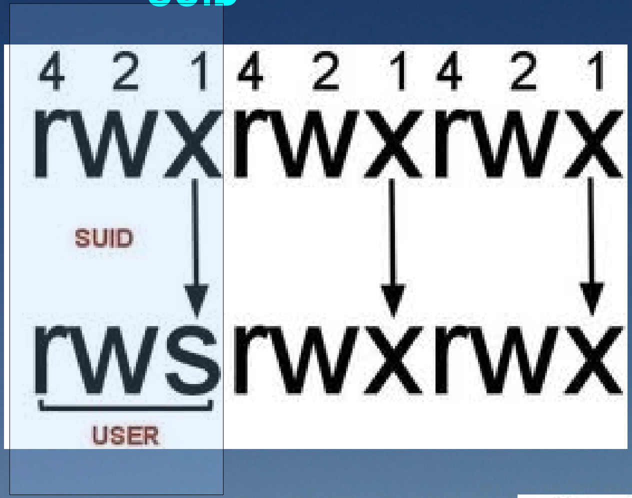
Some References

http://www.tuxfiles.org/linuxhelp/filepermissions.html

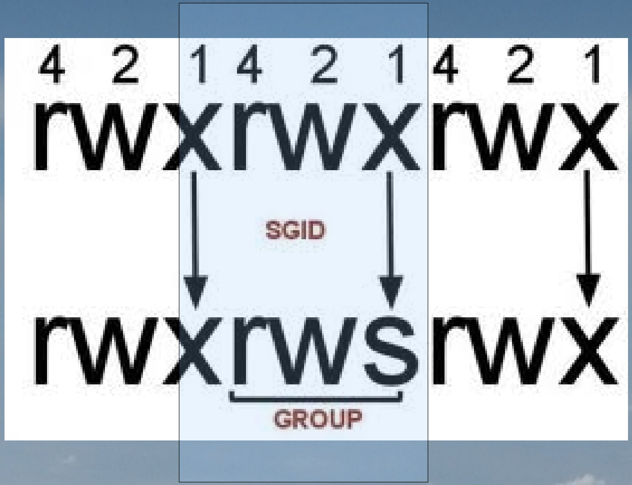
http://www.cs.uregina.ca/Links/class-info/330/Linux/linux.html

http://www.onlamp.com/pub/a/bsd/2000/09/06/FreeBSD_Basics.html

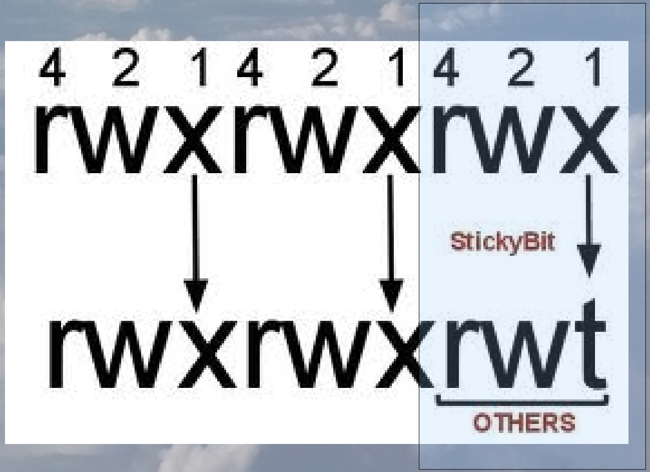
SUID



SGID



STICKY



Set user ID, set group ID, sticky bit

In addition to the basic permissions discussed above, there are also three bits of information defined for files in Linux:

* SUID or setuid: change user ID on execution. If setuid bit is set, when the file will be executed by a user, the process will have the same rights as the owner of the file being executed.

* SGID or setgid: change group ID on execution. Same as above, but inherits rights of the group of the owner of the file on execution. For directories it also may mean that when a new file is created in the directory it will inherit the group of the directory (and not of the user who created the file).

* Sticky bit. It was used to trigger process to "stick" in memory after it is finished, now this usage is obsolete. Currently its use is system dependant and it is mostly used to suppress deletion of the files that belong to other users in the folder where you have "write" access to.

Numeric representation

Octal digit	Binary value	Meaning
0	000	setuid, setgid, sticky bits are cleared
1	001	sticky bit is set
2	010	setgid bit is set
3	011	setgid and sticky bits are set
4	100	setuid bit is set
5	101	setuid and sticky bits are set
6	110	setuid and setgid bits are set
7	111	setuid, setgid, sticky bits are set

Textual representation

- SUID If set, then replaces "x" in the owner permissions to "s", if owner has execute permissions, or to "S" otherwise. Examples:

  -rws------ both owner execute and SUID are set

  -r-S------ SUID is set, but owner execute is not set

- SGID If set, then replaces "x" in the group permissions to "s", if group has execute permissions, or to "S" otherwise. Examples:

  -rwxrws--- both group execute and SGID are set

  -rwxr-S--- SGID is set, but group execute is not set

- Sticky If set, then replaces "x" in the others permissions to "t", if others have execute permissions, or to "T" otherwise. Examples:

  -rwxrwxrwt both others execute and sticky bit are set

  -rwxrwxr-T sticky bit is set, but others execute is not set

File Permissions

- There are two ways to set permissions when using the chmod command:

  Symbolic mode:

  testfile has permissions of -r--r--r--

```
                                           u  g   o*  a
$ chmod g+x testfile        ==>          -r--r-xr--
$ chmod u+wx testfile       ==>          -rwxr-xr--
$ chmod ug-x testfile       ==>          -rw--r--r--
```

- U=user, G=group, O=other (world), All(a)=All

File Permissions cont.

Absolute mode:

We use octal (base eight) values represented like this:

Letter	Permission	Value
r	read	4
w	write	2
x	execute	1
-	none	0

For each column, User, Group or Other you can set values from 0 to 7. Here is what each means:

0= ---	1= --x	2= -w-	3= -wx
4= r--	5= r-x	6= rw-	7= rwx

File Permissions cont.

Numeric mode cont:

Example index.html file with typical permission values:

```
$ chmod 755 index.html
$ ls -l index.html
-rwxr-xr-x    1 root    wheel    0 May 24 06:20 index.html
$ chmod 644 index.html
$ ls -l index.html
-rw-r--r--    1 root    wheel    0 May 24 06:20 index.html
```

Inherited Permissions

- Two critical points:

  1. The permissions of a directory affect whether someone can see its contents or add or remove files in it.

  2. The permissions on a file determine what a user can do to the data in the file.

  Example:

  If you don't have write permission for a directory, then you can't delete a file in the directory. If you have write access to the file you can update the data in the file.

Conclusion

To reinforce these concepts let's do some exercises.

In addition, a very nice reference on using the chmod command is:

An Introduction to Unix Permissions -- Part Two By Dru Lavigne

http://www.onlamp.com/pub/a/bsd/2000/09/13/FreeBSD_Basics.html